Geophysical Research Abstracts
Vol. 13, EGU2011-5375, 2011
EGU General Assembly 2011
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Characteristics of cloud/precipitation distribution revealed by Cloudsat data

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Global distributions of cloud largely effect earth radiation budgets. The heating / cooling effect differs depending on a type of cloud due to the differences of the characteristics of radiative process. Thus, it is important to understand cloud distributions classified into some cloud types. A cloud type classification method has been developed using multiple bands in visible and infrared using geostationary satellite. However, it was hard to classify the cloud types because of limit of information from optical thickness and cloud top height. In 2006, Cloudsat satellite carrying the Cloud Profiling Radar (CPR) was launched, and its observation enables us to find vertical distributions of cloud globally. This study tried to characterize cloud /precipitation characteristics and classify cloud types from vertical distributions of clouds observed by Cloudsat CPR.
We compared semi-simultaneously observed by the radar reflectivity factor (Z) between Cloudsat CPR and TRMM PR to classify the radar echoes from cloud and precipitation. The appearance number of Cloudsat CPR Z at the storm height from Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) (about 17 dBZ) concentrated around 10 dBZ. This difference is explained by an attenuation and overpass time difference. From the appearance frequency of radar echo from Cloudsat CPR and TRMM PR at the same pixel, over 90% of the radar echo detected pixels exists non-precipitating clouds.
Horizontal distributions of mean cloud/precipitation top height (cloudH / stormH) and related parameters are investigated using accumulated Cloudsat CPR data in 2007-2009 June-July-August. Over ocean, cloudH over 12 km appears over the maritime continent, the Bay of Bengal, and the west coast of the Mexico. Over land, cloudH also exceed 10 km over tropical Africa and south-east Asia. However, cloudH over land is generally lower than that over ocean. From the difference between the ascending and descending passes, cloudH over ocean (land) in the early-afternoon pass is higher (lower) than that in the mid-night pass due to diurnal variations of cloud activity. Compared to the CloudH StormH distributions are apparently obscured, but reasonable distributions were found. Frequency of occurrence with stormH to cloudH shows that high frequency regions occur over the Bay of Bengal and the west coast of Mexico, while large differences of the frequency are not found over the mid-latitude region.
This study also applied a base of vertical-method of the PR 2A23 algorithm to the vertical distributions of reflectivity factor (Z) from CPR in order to detect the bright band height (BBH) and cloud types. The detected BBH exists under 250-500 m from freezing height derived from a re-analysis data. The cloud types were classified into convective with large Z, stratiform with BBH, and others. Some case studies showed that TRMM PR rain type algorithms can apply to Cloudsat CPR with some modifications.